November 7, 1881.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-nine persons present.

A paper by Prof. P. T. CLEVE, University of Upsala, Sweden, was read by Prof. D. S. MARTIN, entitled

OUTLINES OF THE GEOLOGY OF THE NORTHEASTERN WEST INDIA ISLANDS.

(Abstract.)

Prof. Cleve's paper contained a resumé of his observations made during 1868–9, in and around the Virgin Islands, and published in the Swedish language in the *Trans. R. Acad. Sci.* of Stockholm, in 1871. He regards the whole group as of Cretaceous and Tertiary age, with the exception of Anegada, which, like the Bahamas, is Post-pliocene.

The strike of the rocks, and the trend of the entire group, are approximately east and west. The rocks are various, largely eruptive and metamorphic. Of these, Prof. Cleve discussed somewhat fully the character and distribution of the following kinds:—1, Dioryte; 2, Felsyte; 3, "Blue-beach" (a peculiar volcanic breccia, locally so-called); 4, Diabase.

All these rocks have great thickness, and indicate long-continued volcanic activity. As in modern lavas, they present two types, basic and acidic.

Metamorphic slates are next described; and then a partly metamor-

phic limestone, occasionally with recognizable fossils, sufficient to fix the age as certainly Cretaceous.

Santa Cruz Island is then described, and referred to the same series as the Virgin group. All these islands thus indicate, by their east and west strike, and the great up-turning of their rocks, that they were formed by a north and south pressure, forcing the Cretaceous and associated volcanic beds into a great line of anticlinal and synclinal folds. This period seems to have been about that of the white Chalk; but the force continued to act during the succeeding Eocene time, though with diminishing intensity, as is shown by the less inclination of the Eocene beds. The Miocene strata are little disturbed, and the force would therefore seem to have spent itself by that period.

Prof. Cleve then refers briefly to the occurrence of similar metamorphic and volcanic rocks in the interior of the Great Antilles, and regards the entire series as having been formed by the same general movement of Cretaceous folding, the Virgin Islands forming the eastern extension of the line of elevation.

The Eocene strata are then taken up and discussed, as they occur in the islands of St. Martin and St. Bartholomew, just east of the Virgin group. Professor Cleve regards these islands as wholly of Eocene age, claiming that the eruptive rocks, of which they mainly consist, are *interstratified* with the limestones, which contain fossils of the age of the Calcaire Grossier, of the Eocene of Paris. He then traces the occurrence of Eocene strata in Antigua, Guadaloupe, parts of Trinidad, and largely in Jamaica; and re-affirms his conclusion that the movement which raised the Great Antilles and the Virgin islands continued during the early Tertiary, though with lessening force.

The Miocene formation is then considered. It forms the small island of Anguilla, and occurs on several of the islands, south to Trinidad; but has immense development in the Great Antilles. It is chiefly a limestone series, is generally little disturbed from a horizontal position, and at times may be seen resting unconformably on the Eocene. By this time, evidently, the disturbing movements had ceased to make themselves felt.

The later Tertiary rocks, Pliocene and Post-pliocene, have not been very clearly marked off from each other or from the Miocene. But to the Post-pliocene period are referred the Bahamas, Anegada, and the remarkable series of volcanic outbreaks that characterize the islands of Saba, St. Eustatius, St. Kitts, Nevis, Monserrat, Guadaloupe, &c. On St. Kitts, Prof. Cleve describes a limestone with over forty species of fossil shells, all but one of which are identified with living species of the Caribbean sea. The same is true of Anegada.

The elevation of the Miocene strata of the Great Antilles took place

apparently by a "continental" up-lift, whereby large areas of marine deposit were raised without folding or disturbance. Professor Cleve suggests that this movement may have been accompanied by a sinking of part of the sea-bottom in the Caribbean region to the south-east, and that, on the limit between the areas of rise and of depression, fissures and faults may have occurred, through which these volcanic outbreaks of the Leeward islands found exit, in the Post-pliocene time.

DISCUSSION.

Mr. A. A. JULIEN confirmed the accuracy of these petrographical distinctions of the rocks of the Lesser Antilles, from the results of observation during a residence of four years on Sombrero and vicinity. The island of St. Eustatius consists mainly of volcanic ashes in a thick tabular and horizontal stratum with vertical faces along its coast. This is flanked on the south end by a volcanic cone with extinct crater, of which the bottom is occupied by a plantain plantation, but the sides are bare, and consist of a dark basaltic rock; and on the north end by two lower cones, not visited but probably volcanic. On the island of Saba the rock is light colored, rich in crystals of sanidine, and apparently a trachyte, constituting a remarkably sharp volcanic cone, with its sides deeply furrowed from top to bottom by eroded ravines; certain depressions upon the summit, resembling craters, present in some localities sulphur deposits which have been found of commercial importance.

However, the conclusion of Prof. Cleve, as to the recent age and eruptive character of most of the crystalline rocks of this region, appeared surprising in view of their metamorphic associates, and of their similarity to those of the Archæan areas identified by Hartt in Brazil. It was a question whether a nucleus of Archæan, or, at latest, metamorphic pre-Silurian rocks, in general highly tilted, does not form the axis of such islands as St. Martin, St. Barts, etc.

Prof. D. S. MARTIN questioned whether a corresponding movement of disturbance should not be also found in the Cretaceous strata of a region no farther removed than that of the vicinity of our own Gulf coast.

Dr. J. S. NEWBERRY remarked that the importance of the subject of the age and origin of these crystalline rocks still demanded their re-examination and a review of Prof. Cleve's conclusions by some worker of experience in this peculiar field. One of the most interesting topographical features on this continent consisted in the line or axis of elevation marked by the Windward Islands, separating the deep basin of the Gulf of Mexico on the one side from the abyss of the Atlantic Ocean on the other. It presents a prolongation and connection of the mountain chains which run along the eastern border of the North and

South American continents, in a course imperfectly parallel to that on the western border of these continents, with the gulf lying enclosed between these two great ranges. This axis has been the scene of violent volcanic action and has been supposed to mark the place of that mythical area of sunken land, styled Atlantis by the ancients. A tradition long current, recorded by Herodotus and others, points to a densely populated land west of Europe, covered with cities, and threatening the civilization of the Eastern hemisphere, which was punished by the gods by being sunk beneath the sea. According to the recent observations of an English geologist, Mr. Thomas Belt, this legend may have had some foundation in the former existence of a continent, now submerged beneath the Caribbean sea, through which the peaks represented by the Lesser Antilles constituted a mountain chain. Local disturbances have certainly affected this area, but we fail to find any evidence of corresponding disturbance in the Cretaceous strata of our southern States, except perhaps in continental elevations and depressions. Messrs. Guppy, Gabb, and others have studied the rocks of the region, but, up to this time, no one trained to the examination of the difficult phenomena and problems under discussion.

November 14, 1881.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-four persons present.

A paper was read by Dr. ALEXIS A. JULIEN on

THE EXCAVATION OF THE BED OF THE KAATERSKILL, N. Y.

(Abstract.)

This paper was supplementary to one read before the Academy two years ago, concerning the phenomena of erosion, glaciation, etc., in the Catskill Mountains, in the vicinity of the Kaaterskill Clove.

Flexure of Strata.— Prof. James Hall has indicated the existence of four lines of flexure, running from N.E. to S.W., the synclinals occupying the summits of ranges, and Prof. Arnold Guyot locates one of these at Slide Mt. The dips at the entrance of the Clove vary from 8° to 10° to the W.N.W., becoming only 3° four miles to the westward, *i. e.*, more nearly horizontal towards a shallow synclinal fold supposed to occupy Hunter Mt.

One of the most interesting discoveries of Guyot was the linear series of three maxima of altitudes above 4000 feet, Slide Mt., Hunter Mt., and Black Dome. The gentle flexure of the whole stratum required to produce this line of maxima may be shown as follows, in the range

running S.E. and N.W. through Hunter Mt., 35 miles long. Toward the S.E., the descent from the crest of Hunter Mt. (Alt., 4038 feet), to Overlook Mt. (3150 feet), is 888 feet, in 9½ miles, equivalent to 1 in 56, or about 1°; toward the N.W., from Hunter Mt. to Utsyanthe Mt. (3203 feet), the descent is 835 feet in 25 miles, equivalent to 1 in 158, or less than ½°.

Another similar series of maxima, however, occurs further to the westward, consisting of Graham Mt. (3886 feet), Bear-pen Mt. (3545 feet), and Ashland Pinnacle (3420 feet), distant respectively 9, 12, and 15 miles westward of the former series. This southward convergence of the axes of these two folds may probably account for the increased protuberance and greater elevations in the Southern Catskills.

Newly determined altitudes.—Many new determinations have been made of points in the vicinity of the Clove, by means of an excellent aneroid, with constant reference to the numerous stations in the vicinity whose altitudes have been accurately obtained by Guyot. A few are here subjoined:

	Feet.
Hotel Kaaterskill, on South Mt.	2466
Parker Hill, summit	2565
Parker Mt., "high ledge."	2874
Clifton House	2101
Newman's ledge, on North Mt.	2486
Gap between E. and W. peaks, North Mt	3116
Toll-gate on Mt. House road	760

Glaciation of summits.—All the crests near the Clove have been now examined. On none above an altitude of 2900 feet have glacial striæ been found, in part because they consist of thinly laminated flags deeply disintegrated by frosts. The highest striæ discovered were found on Parker Mt., "High ledge" (2874 feet), running S. 18° W. (magnetic), and under the roots of a large tree on the SE. slope of Round Top, at an elevation of 2871 feet, running S. 35° E. However, in all cases, a marked difference exists in the slope of different sides of a peak, the E. and S.E. sides presenting a precipitous face, and the other sides more or less of a gentle slope, made up of low terraces.

The highest striæ yet found in the Catskills occur on Overlook Mt., at an elevation of about 3100 feet, implying a depth of ice in the Hudson Valley Glacier of about or at least 3200 feet. Within the Kaaterskill basin, several miles distant from the Hudson valley, the overflowing ice stream became shallower, having an altitude of about 3000 feet. It thus appears that the surface of the glacier inclined westward over these mountains, with a slope of 200 feet in 3 miles, 1 in 84, say about ½°.

The conclusions of the former paper have been confirmed by recent

observation, viz., that two glacier streams have swept over these mountains, the Continental Glacier from the N. W., submerging and carving out the highest peaks, and the Hudson Valley Glacier from the N., later, more shallow, bearing along vast quantities of materials derived from the crystalline and lower Silurian rocks of the Adirondacks and of the Helderberg Mts., and strewing the whole region with their boulders; and that no local glaciers have existed in the Catskills after the retreat of the Hudson Valley Glacier.

Tilting of the Catskill plateau.—In the previous paper an explanation had been given of certain facts which seemed to indicate that the whole formation had been gently inclined to the East and then to the Southeast, before assuming its present W. N. W. inclination, at a period far anterior to the Glacial epoch. A profile section of the ancient Kaaterskill valley was exhibited, reaching from Haines' Falls nearly to the junction of the N. and S. branches of Schoharie creek, proving the gentleness of the slope, the absence of rock, and the existence of a deep and narrow buried cañon, now filled up with moraine material and a capping of peat.

A comparison of the altitudes of Prattsville (1164 ft.), a point on the Western axis, 12 miles distant from the Kaaterskill Clove, and of the lip of the stratum above Haines' Falls (1857 ft.), at the head of the Clove, shows that a depression of the latter point below a line connecting these two points, even to the extent of a single degree, would cause a descent of nearly 700 feet from Prattsville to Haines' Falls, *i. e.*, toward the East. The excavation of the deep Kaaterskill and Plaaterkill Cloves could hardly have been effected by the small streams now occupying their beds. It is more probable that the Schoharie creek formerly flowed, at a higher level, to the eastward into the Kaaterskill Clove, and afterwards toward the south-east into the Plaaterkill Clove, before the latest tilting of the plateau to the W. N. W. caused a reversal of the flow of the stream, in the very opposite direction, through the greater part of the same valley. An objection to this theory presented itself in the obstacle which has created a turn to the S. W. in the North branch of Schoharie creek, near its junction with the South branch. But on recent examination this was found to consist not of rock but of a huge mass of coarse moraine material, deposited during the Glacial period on the southern slope of the Schoharie valley.

Sculpture of the plateau.—In a terrane consisting of strata which dip at varying and perhaps very high angles, the carving out of ranges and production of ravines and gaps may generally be assigned to the occurrence of flexures, of dykes or faults, or of beds whose material is unusually soft, fragile, or rich in minerals of easy decomposition. But the problem of topographical sculpture is less easily solved in a stratum

like that of the Catskills, consisting of a regular succession of layers which are horizontally homogeneous and from which the phenomena of disruption are absent. The original disintegration and erosion of the mass which resulted in the production of the ranges was perhaps mainly influenced by the direction of the jointage. With this the trend of the ranges in the vicinity of the Kaaterskill Clove appears to coincide. The ravines, cloves, and deepest notches and valleys may be attributed to the streams of the present hydrographical basins, or to those connected with the ancient eastward and south-eastward inclination of the stratum already considered. But recent observations on the juxtaposition and coincidence of the highest gaps in successive parallel ranges may possibly indicate the remnants—in cross-section—of the beds of ancient streams at that level (about 3000 feet); this conclusion, if confirmed, would signify an inclination of the plateau to the N.N.E. (or to the S.S.W.?) at a still earlier period, that immediately succeeding its elevation.

Kames.—In the upper basin of the Kaaterskill, several isolated hills of gravel, etc., occur at an altitude of 1924 feet, especially on the bank of the stream near the head of the Clove, which are probably kames; their materials, though largely angular, show traces of imperfect stratification. Near "Blythewood," on the North branch of the Schoharie creek, a curious conical and steep isolated kame rises 102 feet above the stream, made up of rounded pebbles of the Catskill grit, rarely a foot in length, overlying a layer of coarse moraine. Its elevation above the sea (1944 feet) exceeds that of any other kame yet observed, those of the Fintry Hills in England reaching 1280 feet, and those of the Androscoggin Lakes, in Maine, 1600 feet. A very interesting series of from eight to twelve very low kames—like parallel ridges, often curving, made up of large rounded boulders—was also found to follow the course of the Kaaterskill near Palenville, in the Hudson Valley, at the mouth of the Clove, at an elevation of about 700 feet; these probably mark the course of the sub-glacial stream which issued from the mouth of the Clove. The paper concluded with observations on a deposit of laminated sand underlying the ground moraine: on the feeble erosion of the slopes of the Clove during the period which has elapsed since the close of the Glacial epoch; and on a new section of the strata of South Mountain obtained from a recent road cutting.

Discussion.

Prof. E. C. H. Day observed that one portion of Dr. Julien's remarks reminded him of an idea which had struck him many years ago, with regard to the surface geology of a valley on the south coast of England, near Charmouth, in Dorsetshire.

The stream in the valley referred to finds its way to the sea through a narrow pass, which, as attested by the rapid wearing of the coast line and its present configuration, could only have been of (geologically speaking) very recent origin. How the valley could have been drained prior to the existence of this outlet was a question which might be met by various hypotheses; and one of these was that there might have been a slight unequal local change of level, sufficient to have had the effect of tilting the surface of the valley, so that its waters were shed then in a direction opposite to that which they now take. This was nothing more than the veriest hypothesis, made many years ago, without any subsequent attempt at verification. It may suggest, however, the possibility of such slight local changes occurring, in addition to the greater movements already distinctly recognized, and the desirability of careful investigation to discover whether such may not be traced in the altered direction of streams and in the existence of ancient and unused water courses—even in our own neighborhoods. It may be added that such local tiltings of parts of the earth's crust would necessarily influence the course of subterranean as well as of subaerial waters, thus altering the distribution and force of springs at the surface.

Dr. J. S. NEWBERRY stated that the Catskills presented a more complex bit of topography and geology, and one that had been more discussed than perhaps any other of similar area in the country. It was once supposed that these mountains were composed of a single geological formation, which, from this fact, was called the Catskill group; and it was supposed to be a detached table land, deeply carved by erosion. The late Col. Jewett, of Albany, found strata containing Chemung fossils in the Catskills, and from this inferred that the mountains were composed of Chemung strata. Prof. Hall and Prof. Guyot, with their assistants, then made a careful study, running through several years, of the topography and geology of all the surrounding region. Their labors established the fact that the Catskills are not an isolated mountain group, but belong to the Alleghany system and are formed by a series of folds or arches composed of the Chemung and Catskill rocks. Of these folds, the convex arches, as is usually the case, were cracked and broken and, therefore, yielded readily to erosion, while the concave arches, protected and solid, yielded less readily and, in time, by the wearing away of their surroundings, were left in relief, forming ridges with a synclinal structure. Hence it will be seen that the topography of the Catskill region is chiefly the result of erosion.

So far as regards the changes of level from subterranean causes, referred to by Mr. Julien, it would certainly be strange if the foundations of the Catskills were proved to be stable. The old name, "*terra firma*," once applied to the crust of the earth, is a complete misnomer.

and it is really a type of instability. Probably throughout the globe local subsidence and elevation are constantly in progress. In the interior of continents we have no evidence or measure of these, but along coasts the water line tells us that changes are constantly and everywhere taking place, in the relative level of land and sea. About New York the coast is sinking, though very slowly, while further north, in places, it is rising, and Greenland is sinking again. Back from the coast there is no such nilometer, and yet we have no reason to suppose that the earth is more fixed. Some indication is given by the reports of those who dwell in mountainous regions, of changes of level, which have shut from their view that which was before visible, or revealed what was before concealed; but these observations have not been made with accuracy and cannot be depended upon.

In a recent paper before the Academy he had shown the vast changes which had occurred along the coast in this vicinity, viz., that the land once stood 600 feet higher than at present: that the Hudson river had then flowed by the city through a channel from 300 to 500 feet deep, now in large part silted up: that the Palisades then stood from 700 to 800 feet above the river: that the Housatonic then flowed through the East river into New York Bay: that a sub-tropical climate then prevailed throughout this region, with a varied and rich fauna and flora, extending up even to the Arctic Sea: that then a depression of the temperature and great change in the climate ensued, with a corresponding alteration of the fauna and flora; but that these changes were very slow and progressive—the snows, which at first rested temporarily upon the Catskill Mountain summits, became at last permanent, and resulted in local glaciers. These glaciers produced extensive erosion, cutting deeply the channels along which they moved. A partial obliteration of their work then ensued through two agencies. First, a continental glacier advanced southward, overtopping all the mountains, grinding down the asperities of the surface, filling old valleys, and banking up a great mass of debris along its margin—a part of which is now Long Island. Afterward, the climate becoming milder, local glaciers were again formed similar to those which preceded the great Glacier, and partially obliterated or modified the results of the ancient erosion. It is a complex problem now to distinguish between the phenomena which have been respectively produced by all these glaciers in varied succession, by the erosion of streams, by flexures of the earth's crust, etc.

The excavating power of glaciers had been denied by some persons; but ice, hundreds of feet and sometimes miles in thickness—as it was in the old glaciers—moving with irresistible force, and having sand, gravel and boulders beneath it, or frozen into it, was the most potent

agent of erosion known. The eroding power of the ancient glaciers, which once reached southward to Trenton and Cincinnati, was attested not only by the planed down rocks, but by the immense sheet of transported debris left by the glacier in its retreat.

The glaciated, planed, and polished rocks in the Western States are generally covered by a thick layer of clay, abounding in glaciated boulders. There are also other water-worn materials which have been transported, perhaps thousands of miles, representing the gravel bars sand beds, etc., produced by sub-glacial rivers. Although the materials are entirely of glacial origin, all the stones are here usually rounded. We find in these deposits, called kames or eskers, the evidences of the action of running water produced by the melting of ice, their accumulation in heaps, ridges, etc., having been effected by local causes, waterfalls, streams upon or under the ice, etc.

The finer material produced by the same grinding action has been deposited along our coast in the vast masses of the Champlain clays. It is well known that the drainage of all glaciers results in milky streams; *e. g.*, those which descend from the Alps impart an opalescence to the Lake of Geneva, and the streams from the Cascade Mountains are clouded with silt derived from the small glaciers at their heads. So, during the Glacial period all the fine material was sometimes washed out of the glacial drift, leaving banks and ridges, kames, hogsbacks, etc., of gravel and boulders, and carried by streams to the coast and there deposited along shore in the Champlain clays. The fine flour and bran ground by the glaciers have been sometimes referred to different epochs, but they are produced simultaneously. The Glacial or Champlain clays are of great economical importance to the city, as they are the brick clays of Croton Point, Haverstraw Bay, and other points along the Hudson. Their thickness reaches 100 feet along the lower portion of the Hudson river, 400 feet on Lake Champlain, 500 feet at Montreal, 800 feet at Labrador, 1000 feet at Davis' Strait, and 1800 feet at Polaris Bay. This indicates that the continent was depressed to this extent at each of these points, that the waters of the ocean extended through these valleys, and that here was dead water into which the glacier drainage flowed and was deposited.

In the vicinity of New York City it is evident that the glaciers everywhere over-rode and disregarded the underlying topography. All the surface of the island is strewn with materials derived from the N. N. W., and the rock has been planished and striated with grooves running in that direction. The hills back of Yonkers are covered by trap boulders, which have been conveyed across the river from the Palisade range on its western side; and it is plain that the glacier completely disregarded the depression of the Hudson valley, filled it up to a greater or

less extent with *debris*, and so rode smoothly over it. Afterwards this and the other valleys were more or less cleared out by the present streams, but a portion of their contents is generally left in their beds, the tunnel between this city and Hoboken being now driven in fact through a part of this clay deposit. On the east side of the city a narrow cañon, 300 to 400 feet deep, has been proved to underlie the East River; and it would have been a wiser and cheaper plan to construct a tunnel through the clay bottom, for communication with Brooklyn, in place of the present costly and to some extent insecure bridge.

Dr. Newberry finally expressed his interest in the careful study of the erosion and sculpture of the Catskills and desire for its continuance.

November 21, 1881.

SECTION OF BIOLOGY.

The President, DR. J. S. NEWBERRY, in the Chair.

Thirty-one persons present.

The following paper was read by Prof. LOUIS ELSBERG, M. D.:

ON THE CELL-DOCTRINE AND THE BIOPLASSON-DOCTRINE.

Mr. President and Fellows of the Academy, Ladies and Gentlemen:—Last May, at the meeting of the American Laryngolcgical Association, I rendered account of some histological investigations of the cartilages of the larynx, a report of which is published in the October number of the *Archives of Laryngology*. As the structure of hyaline cartilage has an important bearing on my subject of this evening, I crave your attention for a few minutes for a brief review of those investigations.

You know the larynx or voice-box consists of a framework of cartilage or gristle. This cartilage is called hyaline or glasslike, because it is opalescent and looks like milk-glass. Having frequently been examined under the microscope, it has always been looked upon as one of the simplest tissues, namely, as being composed of a hard matrix or basis-substance, in which are imbedded a number of small softer bodies. These softer bodies, the cartilage corpuscles, have since the establishment of the cell-doctrine been called cartilage cells. As these cells were known to be alive, the question which scientific men have had to try to answer was: how can they obtain nutrition, being isolated and enclosed in the firm, unyielding cartilage basis-substance?

Without going too much into details, I may say that it was assumed that nourishing liquid reaches the corpuscle either by imbibition and diffusion or else through canals or fissures in the homogeneous basis-substance. The idea of the existence of "juice-channels" originates with Von Recklinghausen, although others before him had spoken

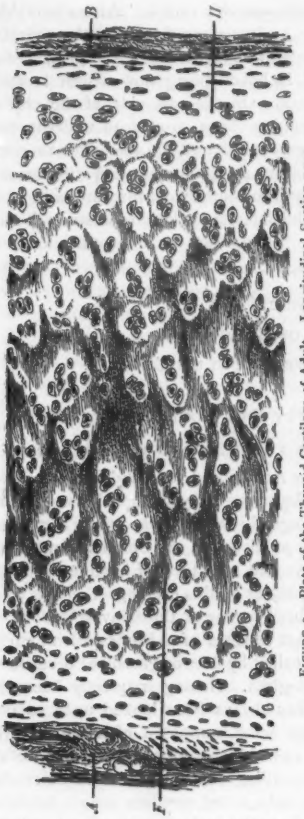

FIGURE 1.—Plate of the Thyroid Cartilage of Adult. Longitudinal Section x 100.
A. Perichondrium towards the mucus membrane. F. Fibrous portion of cartilage in the centre.
B. Perichondrium toward the skin. H. Hyaline portion, on either side, near the perichondrium.
FIG. 1 exhibits the appearance of a longitudinal section of the plate of the thyroid cartilage, with an amplification of 100 diam.

of "pores" through which nutrient juices might pass. Budge and others believe in the presence of regular canals for this purpose, while Tillmanns and many with him believe that hyaline basis-substance consists of fine fibrils so closely held together by a cement-substance that the mass appears to be homogeneous. It is supposed by some that this inter-fibrillar cement-substance is a viscous soft material which permits the imbibition of nutrient liquid; by some that there are clefts or fissures; and by others that there are regular channels tunnelled in this cement-substance. On the other hand, Heitzmann, Spina, Flesch and others have found that there are cilia-like offshoots or prolongations of the substance of the corpuscle penetrating into the basis-substance. Such prolongations might carry on nutrition. I have had the opportunity, six or seven years ago, to repeat Heitzmann's observations under his own eyes and with his assistance; but the results as to their correctness, at which I arrived, were to the best of my belief uninfluenced by him.

My own recent investigations have not only confirmed the existence of such offshoots and shown that they form an inter-connected reticulum or network throughout the basis-substance, but I have discovered in several specimens small lumps in this network which, by all the tests applied to them, were proved to be lumps of living matter in

various stages of existence! These investigations are illustrated by the accompanying drawings.

Doubt as to the interpretation is impossible: instead of being a mass of basis-substance in which a number of cartilage corpuscles are imbedded, hyaline cartilage is a filigree of living matter, in the meshes of which a number of blocks of basis-substance are imbedded.

Now, for our subject proper.

The founder of the cell-doctrine, Schwann, has recorded in the introduction to his great work, published in 1839, that the doctrine was based to a large extent upon investigation of the constitution of carti-

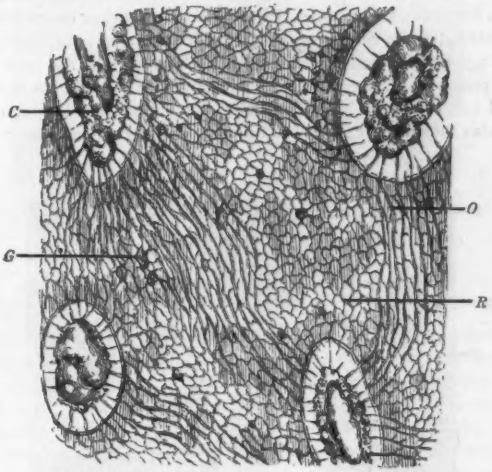

FIGURE 2.—Thyroid Cartilage of Adult, kept in strong Alcohol. Horizontal Section x 1200.

C. Shrivelled cartilage corpuscle.
O. Longitudinal off-shoots.
R. Reticulum in basis-substance.
G. Granules of living matter.

FIG. 2 shows offshoots from the cartilage corpuscles and the network in the basis-substance, with more or less large granules interwoven, as it were, in the network.

lage. After Johannes Müller had described cartilage-corpuscles that were hollow, and Gurlt had spoken of some as vesicles,—when Schwann had succeeded, as he thought, "in actually observing the proper wall of the cartilage corpuscles, first in the branchial cartilages of the frog's larvæ and subsequently also in the fish," he was led by these and other researches to conjecture "that the cellular formation might be a widely extended, perhaps a universal, principle for the formation of organic substances." And just as the study of cartilages has led to

the cell-doctrine, which at the time of its establishment was a great advance in biological science; so the further study of cartilage has supplied the basis for a generalization, which is a further development, and must take the place of the cell-doctrine. This is Heitzmann's doctrine of living matter, or, as I have named it, the *bioplasson-doctrine*.

When the term "cell" was introduced in 1838 and 1839, by Schleiden and Schwann, it was believed that, on ultimate morphological analysis, every plant and every animal would be found to consist of a number of minute vesicles or sacs, enclosing liquid contents in which is suspended a more solid body, the nucleus. For fully twenty years this idea has been known to be erroneous. In fact, Goodsir, nearly *forty* years ago—only a few years, that is, after Schwann had established the cell-doctrine and attributed the vital power to the cell-membrane, I say, nearly forty years ago Goodsir had experimentally determined that the seat of the vital process of secretion is not in the vesicle as such, but in the so-called cell contents; Naegeli, in 1845, and Alexander Braun, in 1851, had also shown the cell-wall to be comparatively unimportant; and in

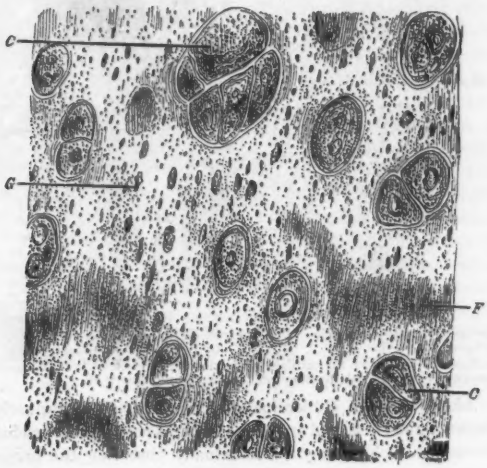

FIGURE 3.—Thyroid Cartilage of Adult. Horizontal Section x 600.

C. Cartilage corpuscle. F. Fibrous portion of cartilage. G. Granules of living matter.

FIG. 3 shows granules of various sizes in the basis-substance, with lower power of the microscope, which granules are seen with higher powers to be connected with the network of living matter, as shown by FIG. 4.

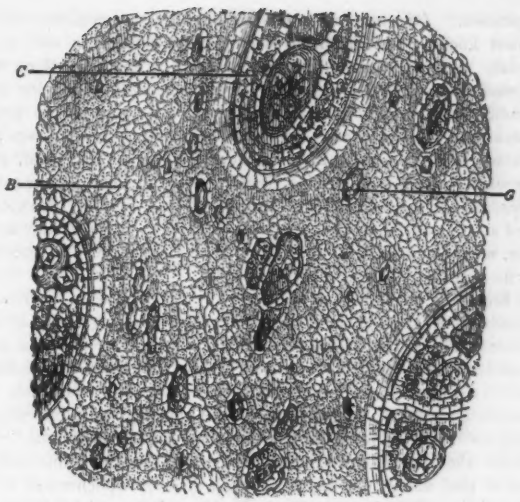

FIGURE 4.—Thyroid Cartilage of Adult. Horizontal Section x 1200.
C. Cartilage corpuscle. B. Hyaline basis-substance. G. Granules of living matter.

1857 Leydig had declared the "cell" to consist only of a soft substance enclosing a nucleus. Certainly, twenty years ago it was proved beyond dispute by Max Schultze, Beale, Hæckel, and others, that what was called a "cell" was not a vesicle, but essentially a jelly-like lump of living matter characterized by the presence of a nucleus; soon after, Robin, Brücke, Kühne, Stricker, and others, conclusively showed that not even a nucleus is an essential constituent of an elementary organism; and biologists were compelled to transfer the power of manifesting vital properties to "living matter," instead of restricting this power to any definite form-element. As long ago as in 1861, Brücke proposed to discontinue the use of the word "cell" as being a misnomer and misleading, and offered as a substitute the expression "elementary organism." Beale proposed, instead, the term "bioplast" to designate any definite mass of living matter, and Hæckel the term "plastid." From the latter I devised the word "plastidule," as synonymous with ultimate molecule of the substance of living matter. Elementary living matter is called with Dujardin "sarcode," or with Von Mohl "protoplasm," or with Beale "bioplasm," or, still better (because it is a designation etymologically more nearly meaning living, forming matter),

"bioplasson." Of these four synonymous terms, "protoplasm" is the one best known; but has been used in other senses, as well as to designate merely elementary living matter. I therefore think that "bioplasson" is to be preferred. Of course, *dead* bioplasson is a contradiction in terms: bioplasson deprived of vitality is no longer bioplasson at all, but merely the chemical remains of what *once was* bioplasson. If this be remembered, there will be no confusion, even if the word be used in describing tissues, etc., after death. According to Drysdale, Dr. John Fletcher of Edinburgh was the first, who clearly arrived at the conclusion that "it is only in virtue of a specially living matter, universally diffused and intimately interwoven with its texture, that any tissue or part possesses vitality."

As Fletcher's work was published in 1835, several years before even the establishment of the cell-doctrine, we cannot but agree so far with Drysdale as to say that Fletcher has framed a "hypothesis of the anatomical nature of the living matter which anticipates in a remarkable manner" its discovery! In 1850, Cohn[1] recognized the protoplasm "as the contractile element, and as what gives to the zoöspore the faculty of altering its figure, without any corresponding change in volume." He concludes that protoplasm "must be regarded as the prime seat of almost all vital activity, but especially of all the motile phenomena in the interior of the cell." In 1853, Huxley[2] said, "vitality, (the faculty, that is, of exhibiting definite cycles of change in form and composition), is a property inherent in certain kinds of matter." In 1856, Lord Osborne discovered carmine staining, and distinguished, by means of coloring it, the living formative matter from the formed material, a means which has borne important fruits in the discovery of Cohnheim's staining of living matter by gold chloride, and in that of Recklinghausen's staining all except living matter by silver nitrate.

In 1858, and in a number of later articles,[3] Max Schultze, by showing that, as had been hypothetically supposed by Unger, the movements of the pseudopodia and the granules are really produced by active contractile movements of the protoplasm, as well as by other observations, contributed much to the establishment of the theory of living matter. Hæckel has also for many years, and in various publications,[4] labored to

[1] "Nachträge zur Naturgeschichte des Protococcus pluvialis." *Nova acta Acad. Leop.-Carol.*, vol. xxii, part i, p. 605.

[2] "Review of the Cell-theory." *British and Foreign Medico-chirurg. Review*, Oct., 1853.

[3] "Ueber innere Bewegungs-Erscheinungen bei Diatomeen," *Müller's Archiv*, 1858, p. 330; "Ueber Cornuspira," *Archiv f. Naturgesch.*, 1860, p. 287; "Ueber Muskelkörperchen und das was man eine Zelle zu nennen habe," *Reichert und Du Bois-Reymond's Archiv.*, 1861, p. 1; Das Protoplasma der Rhizopoden und der Pflanzenzellen, Leipzig, 1863.

[4] Monographie der Radiolarien, 1862, pp. 89, 116; "Ueber den Sarcodekörper der Rhizopoden," *Zeitsch. f. Wissensch. Zoölogie*, 1865, p. 342; Generelle Morphologie, vol. i, pp. 269, 289.

maintain and extend the same theory, of which he thus expresses himself,[1] "the protoplasm or sarcode theory, that is, the theory that this albuminous material is the original active substratum of all vital phenomena may, perhaps, be considered one of the greatest achievements of modern biology, and one of the richest in results." And, says Drysdale[2], "if the grand theory of the one true living matter was, as we have seen, hypothetically advanced by Fletcher, yet the merit of the discovery of the actual anatomical representation of it belongs to *Beale*, in accordance with the usual and right award of the title of discoverer to him alone who demonstrates truths by proof and fact. * * * The cardinal point in the theory of Dr. Beale is not the destruction of the completeness of the cell of Schwann as the elementary unit, for that was already accomplished by others, * * * but that, from the earliest visible speck of germ, up to the last moment of life, in every living thing, plant, animal, and protist, the attribute of life is restricted to one anatomical element alone, and this homogeneous and structureless; while all the rest of the infinite variety of structure and composition, solid and fluid, which make up living beings, is merely passive and lifeless formed material. This distinction into only two radically different kinds of matter, viz., the living or germinal matter and the formed or lifeless material, gives the clue whereby he clears up the confusion into which the cell-doctrine had fallen, and gives the point of departure for the theory of innate independent life of each part, which the cell-theory had aimed at, but failed to make good. The one true and only living matter—called by Beale germinal matter, or bioplasm—is described as 'always transparent and colorless, and as far as can be ascertained by examination with the highest powers, perfectly structureless; and it exhibits those same characters at every period of its existence.' * * *"

"The name of bioplasm," continues Drysdale, "given by Beale, or protoplasm, as indicating the ideal living matter, cannot be given to any substance displaying rigidity in any degree: nor to anything exhibiting a trace of structure to the finest microscope: nor to any liquid: nor to any substance capable of true solution. Thus 'nothing that lives is alive in every part,' but as long as any individual part or tissue is properly called living, it is only so in virtue of particles of the above-described protoplasm, freely distributed among, or interwoven with the textures so closely that there is scarcely any part, $\frac{1}{100}$ of an inch in size, but contains its portion of protoplasm. Thus we see realized the

[1] Monographie der Moneren," *Jenaische Zeitschrift f. Medicin und Naturwissenschaft*, 1868, iv, 1; translation in *Quarterly Journal of Microscopical Science*, London, 1869, vol. ix, p. 223.

[2] *Loc. cit.*, 42, *et seq.*

hypothesis of Fletcher, that all living action is performed solely by virtue of portions of irritable or living matter interwoven with the otherwise dead textures." The objection, however, urged by Bastian to Beale is so very pertinent, that it must also find a place here, but I shall not dwell upon other points on which Beale differs from the bioplasson doctrine; such as, that living matter exhibits the same characters at every period of its existence; and that it is always perfectly structureless. "It has always appeared to me," says Bastian,[1] "to be a very fundamental objection to Beale's theory, that so many of the most characteristically vital phenomena of the higher animals should take place through the agency of tissues—muscle and nerve, for instance—by far the greater part of the bulk of which would, in accordance with Dr. Beale's view, have to be considered as *dead* and inert."

In 1873, the morphological knowledge of living matter became exact. In that year, Heitzmann discovered the manner in which bioplasson is arranged throughout the body, and announced the fact that what had until then been regarded as separate form-elements in a tissue are really interconnected portions of living matter; that not only are there contained no isolated unit-masses in any one tissue, but no tissue in the whole body is isolated from the other tissues; and that the only unconnected particles of living matter are the corpuscular elements of liquids, such as blood, sperm, saliva, pus, etc., and so-called wandering corpuscles; so that, to use his own words: "the animal body as a whole is a connected mass of protoplasma in which, in some part, are imbedded isolated protoplasma-corpuscles and various not-living substances (glue-giving and mucin-containing substances in the widest sense, also fat, pigment-granules, etc.)." This announcement marked the commencement of a new era in biology.

Heitzmann discovered that the living matter as seen in an amœba is *not without structure*, as had, before his accurate investigations, been supposed; and that its structure, in all cases when developed, is that of a network, in the meshes of which the bioplasson fluid, or the not-contractile, not-living portion of the organism, exists. When there is a nucleus, it is connected by delicate threads with the extra-nuclear network; nucleoli and nucleolini inside of the nucleus, as well as granules outside, are portions of living matter: sometimes in lump, sometimes mere points of intersection of the threads constituting the intra-nuclear and extra-nuclear living networks, sometimes terminals of section of such threads, as first explained by Eimer,[2] and after this author by

[1] The Beginnings of Life: being some account of the nature, modes of origin, and transformations of lower organisms. London, 1872, vol. i, p. 255.

[2] "Weitere Nachrichten über den Bau des Zellkerns." *Archiv f. mikrosk. Anatomie*, xiv, 1877, p. 103.

Klein.[1] Heitzmann discovered that what is true of the structure of bioplasson in the amœba, where a single small unit-mass of living matter constitutes the entire individual, is true also of the structure of bioplasson of all, even the highest, living organisms.

To be sure, much had been previously known regarding protoplasm or living matter, but the knowledge was fragmentary, until Heitzmann demonstrated not only that membrane, nucleus, nucleolus, granules, and threads are really the living contractile matter; but also, *first*, that this matter is arranged in a network, containing in its meshes the non-contractile matter, which is transformed into the various kinds of basis-substance, characterizing the different tissues of the body; and *secondly*, that the tissue masses of bioplasson throughout the whole body are interconnected by means of fine threads of the same living matter.

Unless these two facts of Heitzmann's discovery are accepted, there cannot be urged much against the continued use of the word "cell," misnomer though it be. Ranke,[2] after speaking of the "cell-wall," "cell-nucleus," etc., says: "of these component parts of the cell, one or other may be wanting without the totality ceasing to be a cell. The nucleoli, the cell-wall, or the nucleus may be wanting, and yet we must designate the microscopic form a cell, or elementary organism." Drysdale thus comments upon this quotation, viz.: "if any one choose to describe a gun-barrel as a stockless gun without a lock, he is free to do so; but what good purpose can it serve? Or is there even any fun in it? The truth is, this clinging to the mere name of the cell-theory by the Germans seems to arise from a kind of perverted idea of patriotism and of *pietas* toward Schwann and Schleiden." But I think Tyson[3] has the better of the argument, in saying: "the word "cell" has become so intimately associated with histology, that it is doubtful whether it will ever fall into disuse, nor does it much matter, so long as correct notions of the elementary part are obtained." Now, if there were any separate and distinct "elementary part," it certainly would matter little or nothing whether it were called "cell" or by any other name, provided the name be properly defined and agreed upon. It is not against the name but against the idea of any isolated individualized form-element that the objection lies. Virchow maintains, "that the cell is really the ultimate morphological unit in which there

[1] "Observations on the Structure of Cells and Nuclei," *Quarterly Journal of Microscopical Science*, Jan., 1879, p. 128. "The intranuclear as well as the intracellular network having, of course three dimensions, includes fibrils that lie in the two dimensions of the plane of the field of the microscope, as well as fibrils placed vertically to it. The former appear, of course, as fibrils; but, I should like to ask, as what do the latter appear, *i. e.*, those situated vertically. Clearly as dots, because they are seen endwise; and for obvious reasons most of them lie in the nodes of the network."

[2] The Cell-Doctrine; its history and present state. Philadelphia, 1878, p. 128.

[3] "Physiologie, 1872," quoted by Drysdale, *loc. cit.*, p. 104.

is any manifestation of life, and that we must not transfer the seat of real action to any point beyond the cell."[1] Against this statement nearly every author nowadays protests, and insists that vital power must be transferred from the "cell" to "living matter"; yet, after all, the disagreement, though ever so strenuously declared, is a mere verbal one: so long as both parties hold that "every higher animal presents itself as a sum of vital unities"—no matter what these unities are called or how defined. Hæckel, one of the most avowed advocates of "the protoplasm or sarcode theory," clings to Virchow's politico-physiological comparison, that every higher organism is like an organized social community or state in which the individual citizens are represented by the "cells," no matter how he may define these, each having a certain morphological and physiological autonomy, although on the other hand interdependent and subject to the laws of the whole. Heitzmann's views necessitate the comparison of the body to a machine, such as a watch or a steam-engine, in which, though there are single parts, no part is at all autonomous, but all combine to make up one individual. Even Huxley, the popular champion of protoplasm as the physical basis of life, quite recently delivered an address, before the International Medical Congress in London, August 9, 1881, in which he used the following language: "in fact, the body is a machine of the nature of an army, not of that of a watch, or of a hydraulic apparatus. Of this army, each cell is a soldier," etc., etc. According to Hæckel and Huxley, the body is composed of colonies of amœbæ; according to Heitzmann the body is one complex amœba. I am very anxious to really make the difference between the cell theory and the bioplasson theory clear to every one of you. The essential point of the cell theory is the idea, that the body and each tissue of the body, every plant, and every animal, is made up of a number of distinct units; and the essential point of the bioplasson theory is the idea, that all the masses of living matter of each tissue of plants and animals are uninterruptedly connected, and that every tissue is connected with every other tissue by filaments of living matter. To accept Mr. Huxley's comparison, we must imagine that every soldier is indissolubly connected, hand and foot, with every neighboring soldier of the solid army!

There is no better test of the truth of the bioplasson doctrine than the structure of hyaline cartilage. If hyaline cartilage consisted, as "is generally believed," of "a homogeneous ground substance, in which are closed cavities harboring the corpuscles," the bioplasson doctrine would certainly be erroneous. If it merely contained lymph, or juice-channels, no matter what their character, whether open or

[1] Die Cellularpathologie in ihrer Begründung auf physiologische und pathologische Gewebelehre, Berlin, 1858, p. 3. (Translation by Chance, London, 1859, p. 3).

closed, whether lined or unlined, whether in "homogeneous basis-substance," or "between layers of cells," or "in cement-substance,"[1] then, too, the bioplasson doctrine would be erroneous.

But the result of my observations, especially those illustrated in figs. 2, 3, and 4, admit of but one interpretation, and that an interpretation favorable to the bioplasson doctrine. It is unnecessary to more than mention that although I have placed on record so few, I have made many different examinations, under many different circumstances, and with varying powers of amplification. I need occupy myself here with only the two fields drawn in figs. 3 and 4, with an amplification of 600 and 1200 respectively. The remarkable specimens from which they are taken show more conclusively than it was ever before shown what the structure or constitution of hyaline cartilage really is. I think I have explained this sufficiently, but its full significance appears in its corroboration of the bioplasson doctrine.

To be able to uphold the cell-doctrine, cartilage would have to be, using a homely comparison, like a cake composed of hard dough with raisins. No matter how widely we may extend the definition, to remain within the boundary of the cell-doctrine this metaphor must be applicable. Innumerable painstaking researches have led to various modifications of notions entertained regarding the structure of the two constituents of the cake and their relation to each other. It may be seen by the most recent publications on the subject, that the acceptation of the existence in the dough of cleavage in certain directions, of interlaminary and interfibrillar spaces, and of offshoots, even ramifying prolongations of the raisin-substance, or, at all events, of an ingredient of the raisins, is held to be not incompatible with the cell-doctrine. If, however, we can represent cartilage as a filigree or framework of raisin-substance, in the meshes or interspaces of which framework blocks of dough are imbedded, certainly the fundamental view of the ultimate construction of the tissue is changed, and we are no longer in accord with the cell-doctrine, even though we be inclined to use that term in the widest possible sense. Look for a moment at the two illustrations on the blackboard, as well as at figs. 2, 3, and 4. The upper figure represents a section of cartilage stained with gold chloride.

This, as I have already explained, stains the living matter and leaves the basis-substance unstained. High powers exhibit the appearance, etc., etc. In regard to a name as a substitute for the term "cell," I would say that all corpuscular masses may be called, simply, corpuscles

[1] These statements of the general belief are quoted from the introductory paragraph of Thin's memoir, "On the Structure of Hyaline Cartilage" (*Quarterly Journal of Microscopical Science*, xvi, 1876), in which Thin's own views are laid down to the effect "that layers of cells epithelial in arrangement exist in the substance of cartilage," "that both the stellate and the parallel systems of lymph-channels exist," etc.

—thus we may speak of blood-corpuscles, pus-corpuscles, etc. For all the accumulations of living matter within the ordinary fields of basis-substance, but more especially for those smaller masses which, having as yet developed neither a network structure nor much vacuolation, are still homogeneous, or nearly so, I am quite willing to adopt either the designation of "plastids," proposed by Hæckel, or that of "bioplasts," proposed by Beale. Perhaps it would be well to restrict the word "bioplast" to a small mass of living matter exhibiting no differentiation, and distinguish from it as "plastid" the larger mass showing an interior structure more or less like the fully developed corpuscle. Thus, I would always use the term "plastid" in the place of "cell."

The result of my investigations as to the structure of cartilage is that in this tissue, beyond the possibility of a doubt, the living matter is arranged in the form of a network, containing in its meshes the non-contractile matter. How is it with regard to the other proposition of the bioplasson doctrine, viz., that the living matter of the different tissues is interconnected? Examinations with high powers of such a specimen as that represented in fig. 1, showing the perichondrium of horizontal sections through the larynx, or the neck, with skin and more or less of other tissues included, enable me to answer this question to the effect that fine filaments of living matter pass from one tissue to another in connection with the network of living matter in each. The details of these examinations are reserved for another time. But it has been suggested to me that I ought not to conclude without saying a few words as to the practical advantages of the Bioplasson Doctrine over the Cell-Doctrine. Every exact scientific investigation, even though at first of theoretical value only, sooner or later brings with it some practical benefit; and this doctrine of living matter, aside from the satisfaction which the perception of abstract truth grants—lying as it does at the foundation of our knowledge of living things—has advanced their physiology and pathology at every point. In practical medicine it has already aided us in so many ways that their merest enumeration would require another hour's lecture. We know that the disposition of living matter is different in different persons, and that in the case of increased supply of food the reaction is different in strong and healthy people from that in the sick and weak. Upon this knowledge rests, to-day, the *whole doctrine of pulmonary consumption*. Now, the amount of living matter within the same bulk varies greatly both in normal and morbid conditions. A small lump of bioplasson in the urine or expectoration, taken from an individual of good constitution, will show a close network with coarse granulations, or perhaps be almost homogeneous-looking under the microscope—owing to the large amount of living matter in the small bulk: while a plastid, from a

weak, broken down or phthisical person, will be finely granular and exhibit a network with large meshes on account of the relatively small amount of living matter in it. Sometimes we thus, from the examination of a drop of blood, gain an insight into the condition and vital power of the whole individual; sometimes, recognize a disease before it is sufficiently developed to do much harm, and thus come a step nearer to the highest aim of the physician—the prevention of disease.

DISCUSSION.

Dr. B. N. MARTIN remarked on the great value and important bearing of this investigation.

Mr. A. H. ELLIOTT enquired whether the blocks of non-living matter in the cartilage were entirely separated.

Dr. ELSBERG explained that the blocks were separate, their only connection being the interposed threads of the *reticulum* of living matter; and to the former is due the opalescent character of hyaline cartilage. He further stated that the condition of health of an individual might be inferred in a degree from a study of the character of the network, a thin section of a very minute portion of the body often showing a difference of network in different persons, *e. g.*, in the thickness of the threads, the size of the meshes, the character of the points of intersection, etc. From the uniformity in the size of the meshes, etc., or from their variability, or from the proportion of corpuscles presenting a normal and abnormal character in their network, a good or bad prognosis was deduced by the physician, and even an indication of the progress of disease.

Prof. E. H. DAY referred to the wonderful character of protoplasm in its wide results in the construction of the most varying textures in the vegetable and animal kingdoms. The speaker's observations have brought the protoplasm of cartilage tissue into correspondence with that in the tissues of the sponge, of the plant, and all the lower forms of life. In protoplasm we are brought face to face with the most astonishing substance in nature.

Mr. J. D. WARNER offered objections to the vague views of Virchow on the soul of the cell and its relation to the soul of the individual.

Dr. NEWBERRY said that, having been educated as a physician, and having studied microscopic anatomy under Dr. Charles Robin, he had followed with great interest the progress of modern research into the ultimate structure of organic tissue, and the discussions of the origin and seat of vitality to which it has given rise; and he regarded such investigations as those of Dr. Elsberg as of the highest scientific interest and practical value. If we ever learn the causes of malarial and infectious diseases, or the cure of the morbid growths which are

the scourges of humanity, cancer and tubercle, it will be through such researches. But he thought that much of the discussion which had been excited by these investigations had been irrelevant and confusing, especially that in regard to the seat and nature of life, into which microscopists and chemists had entered with great earnestness and some acrimony, but with no satisfactory result. In this discussion some writers had made the ultimate cell the seat of life, and had glorified and almost deified it. Others claimed that the cells were only portions of a general vitalized and automatic tissue; while others still contended that the phenomena of vitality were the mere manifestations of chemical changes taking place in structure otherwise lifeless.

With none of these views could he sympathize, as there had really been no approach to an end in the effort to localize or analyze life. Unless we accept the materialistic theory of spontaneous generation, advocated by Dr. Bastian, but rejected by most biologists, we must confess that no more is now known of the origin, nature and seat of life than was known to Aristotle. All we have done is to acquire a better knowledge of the *machinery* by which the functions of life are accomplished; most important knowledge truly, since it enables us to distinguish between normal and morbid life action in the tissues where this action begins, and promises to point the way for promoting the one, and preventing the other—but limited to the methods in which the life force acts, not reaching the inscrutable and intangible force itself.

The work done by a microscopic cell is wonderful and incomprehensible to us, yet all cells work not as independent individuals, but as members of a community, and for a common end. For example, the terminal cell of the fibril of a plant root is a delicate vesicle—the cell in its simplest form, and yet when new born, and having existed but the fraction of a minute, it begins its special work of supplying certain food elements to the plant above; and this it does with a discrimination which is infallible. Water it absorbs by endosmosis, and, when deficient, begets progeny to send for it. It also appropriates other things that are necessary to the growth of the plant to which it belongs, whatever that be; if tobacco, an unusual quantity of potash; if grass, of silica. It always works to a pattern determined by the character of the plant whose general economy it serves, and is controlled by the influence which gives to that plant its special and recognizable leaf, flower and fruit, its noxious or alimentary qualities. So in all other parts of the structure the cell is doing its allotted work in a community of which it forms an integral part. It is therefore in no sense an independent individual. Our notions of what constitutes an individual or a community may seem to us quite clear, but they are in fact likely to be somewhat confused. Every man recognizes and asserts his own individuality, but

we all know that men who live in communities often think and feel as one though many. A great grief crushes all alike, a great danger rallies all in defence. The social insects, ants and bees, retain their corporeal individuality, but are curiously linked together in a common life that makes each but a part of a whole. A tree is universally accepted as an individual, but, as all know, it may be divided to form an unlimited number of perfect trees which expand this individual into a forest and prolong its life indefinitely. The sponge is said to be a community of amœboid individuals, but these share a common skeleton, fashioned for the wants of all, and all unite in the general function by which the inhalent and exhalent currents are maintained, a function on which the life of all depends. In the corals which live in communities, we find the common skeleton covered with a vitalized gelatinous integument on which are set here and there the individual polyps. These live to a great degree each for itself; each throws out its tentacles and forages for its own support, but at the same time it shares a life with its neighbors; an injury done to one affects those about it, and a misfortune involving a sufficient number destroys the life of the colony.

The elusive and intangible nature of the life which pervades plant tissue is well shown in the growth and decay of a tree. From a microscopic germ a young *Sequoia* springs into existence, and for a thousand years or more lives its life. All this time it is inspired by a power which acts in antagonism to the affinities of inorganic chemistry in opposition to the force of gravitation, and which builds up a mass hundreds of tons in weight, mostly obtained by the breaking up of one of the strongest bonds in chemistry, that of carbonic acid, appropriating the carbon and setting the oxygen free. Every part of the huge structure is pervaded by this peculiar creative and conservative influence; and every cell of root or stem or leaf contributes its part to the harmonious whole. At length the time arrives when this peculiar influence which we call life deserts the structure it has created. The affinities of inorganic chemistry now assert themselves, all the ephemeral fabric is rapidly disorganized, and soon a heap of ashes—the inorganic matter woven into its composition—alone remains to tell of its existence. Who can tell us what was the nature of the enchantment which created this Aladdin's palace—whence it came, where it dwelt during its sojourn, and whither it has gone? We may say it resided in the terminal root cells; but these are inseparably connected with the leaves, hundreds of feet above. The tie that binds them is a vital one; neither could live without the other, nor without the intervening chain which connects them.

By studying the anatomy of plants and animals, we obtain a knowledge of the organs and laws, as we call them, of animal and plant life;

that is, we get a knowledge of the machinery with which the functions of life are accomplished, a knowledge of the order and manner in which these functions are performed; but the *primum mobile*, the real "power behind the throne," remains as yet unseen and unknown to us.

November 28, 1881.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The hall was filled to overflowing.

In introducing the lecturer of the evening, the President stated:

'Captain Cheyne asks you to examine his plans carefully. He has been with three expeditions to the Arctic regions, and has spent there five and a half years. He has been there under so many circumstances that he knows, perhaps better than any other man, the difficulties to be encountered and how to overcome them. He comes recommended by the highest authorities in England. His plan is not chimerical, and it is certainly heroic. Men will yet surely go to the Pole, if they have to crawl there on their hands and knees; and an enterprise of this kind is worthy of attention in these days, if only to withdraw the minds of men from their shops and money-getting and purely selfish occupations."

COMMANDER JOHN P. CHEYNE, R. N., F. R. G. S, then delivered the following lecture:

THE DISCOVERY OF THE NORTH POLE PRACTICABLE.

(Abstract.)

Reference was first made to the large number of local committees—sixty-two—and of influential persons in England who have signified their approval of this enterprise.

A Council has been formed in England and is now awaiting the news from America. As soon as it has heard of action taken here toward the formation of an Anglo-American expedition, the members of the Council will bestir themselves. It was originally designed, by means of an expedition, the cost of which would have been about £30,000, to include the circumnavigation of Greenland, besides the journey to the North Pole.

The following plan is proposed for reaching the Pole. A small vessel will be engaged to convey the exploring party, with provisions for two years and a half, to St. Patrick's Bay, near Discovery Harbor, leave them there, and immediately return. The party will consist of

seventeen persons all told, including Lieut. Schwatka, U. S. A., the commander of the late American Franklin search expedition, who has most cordially volunteered to accompany this party, on the part of America.

To attempt to reach the Pole in the usual manner, there would be required six sledging parties of five men each. Each man would have to drag 215 pounds. The Lecturer believed that the journey could be performed by means of sledges, as he had not the most remote idea that there is an open sea about the Pole. Starting in April or early May with the six sledges, they would go fifty or sixty miles on the journey; and then sledge No. 6 would stop and bury in some safe place all its spare supplies, as a depot for the return journey, and that sledge would return to the ship. After going fifty or sixty miles more, the fifth sledge would stop in the same way, bury its spare provisions, and return to the ship. The first sledge would keep on until the Pole was reached. In this way the journey might be made in 106 days, but would be far more difficult and laborious than that proposed by the following plan.

On arrival at St. Patrick's Bay, three snow observatories will be established, one situated in the immediate vicinity of the coal mine, at St. Patrick's Bay, another fifty miles further north, and the third the same distance to the south. These observatories will be connected by telegraph wires, and hourly meteorological observations will be taken and transmitted to the central station. Thus accurate information as to the direction and force of the wind, simultaneously over a distance of one hundred miles, will be obtained and immediately plotted at the central station. When the proper wind curve for reaching the Pole is found to exist, the attempt will be made by means of balloons. These will be of large size, and three in number, costing altogether about £12,000. Each will carry three men, be provided with a boat car, a set of Esquimaux dogs, and provisions for fifty-one days. The total load for each balloon will be between one and one-half and two tons. The gas for inflating the balloons will be generated, at least mainly, from the abundant coal at this harbor, and, to prevent the too rapid diffusion and loss of gas, it is proposed to employ a double envelope of silk with an intermediate layer of gold-beaters' skin. It has not yet been decided whether to use pure hydrogen or a mixture of coal gas and hydrogen. The Commander has convinced himself by experiments with balloons, both in polar regions and in England, that they can be satisfactorily used in the way above proposed; and he hopes to cover the distance from St. Patrick's Bay to the Pole, 496 miles, in from eighteen to twenty-four hours. The altitude of the balloons will be regulated at about one thousand feet by means of a trail rope.

After arrival at the Pole, advantage will be taken of a favorable wind to return to St. Patrick's Bay, or, possibly, to continue in one balloon right on to some part of Russia, should it appear better to take that course. Any loss of gas during the balloon trip, which may be found to have occasioned a deficiency on arrival at the Pole, or during a short stay there for scientific observations, may be remedied by the abandonment of one balloon and the transference of its gas into the other two, and, possibly, by the conveyance of a small supply of hydrogen in steel cylinders.

Many interesting arctic phenomena were discussed: *e. g.*, the proofs that the aurora borealis was not caused by atmospheric electricity but by magnetism: the numerous parhelia and mock moons visible in polar regions: the mode of formation of glaciers and icebergs, and the curious shapes assumed by the latter.

The coal of the mine at St. Patrick's Bay was described as equal to the best Welsh, almost smokeless, and existing in very large quantities. The present meagre flora of Greenland was compared with the rich ancient flora, almost tropical in character, shown by the fossil plants found in the Tertiary beds of the vicinity of Disco. More than fifty species of trees and shrubs have been obtained from these deposits.

In conclusion, the Lecturer spoke of the very probable success of the proposed Anglo-American expedition now being organized by Lieut. Schwatka and himself, and stated that the estimated expense, at a minimum, is to be £16,000, each country to provide half of this sum, and all discoveries to be equally shared by the two nations. The Commander laid great stress upon the good feeling existing between America and England, expressing the opinion that the organization of such a joint expedition as proposed, especially if the two national flags were to be planted side by side at the world's apex, would so materially develop that feeling, that therein would be at once an answer to those questioners who asked "*cui bono?* What commercial return can we expect for our expenditure for equipment?" Further utilitarian achievements were then touched upon, as relating to the more thorough study of the sea-bottom by soundings, and of the oceanic currents within the Arctic circle, so that in time commerce will be enabled to work out more definite highways for the passage of ships across the ocean; also to the development of knowledge in different branches of science, in addition to the advantages that might accrue in opening up and investigating such a vast unknown area.

At the conclusion of the lecture, the audience expressed, by a show of hands, its hearty interest in the subject, after the delightful mode of its presentation and illustration by Commander Cheyne, and its recommendation of the matter to the careful consideration of the public.